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# HARBOUR IMPROVEMENTS

AT

## FOOT OF LACHINE CANAL,

CONSIDERED IN A REPORT

ADDRESSED TO THE PROPRIETORS ON MILL STREET,

BY

CHARLES LEGGE,

CIVIL ENGINEER.



MONTREAL :

HERALD STEAM PRESS 209 NOTRE DAME STREET.

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MONTREAL, January 17, 1862.

*To the Proprietors on Mill Street:*

Gentlemen,—In accordance with instructions received from you, through Messrs. Gould, Grant and Hall, I have prepared plans and estimates for improvements in front of Mill Street, which are herewith submitted for your consideration.

In so far as my knowledge extends, of the various schemes heretofore suggested, for the extension of Harbor and Warehouse facilities in the Port of Montreal, the present one differs materially both with reference to the general plan, and the mode in which it is proposed to be carried into execution.

The plans for Hydraulic Docks, and a City Terminus for the Grand Trunk Railway, lately prepared under the instructions of a Provisional Committee, would if constructed answer every requirement of trade and manufactures for all time to come, be the increase what it might; the very magnitude of the entire scheme may, however, have the effect of postponing the commencement and completion to a period so far in the future, that it becomes a serious question, in view of the embarrassments the present trade of Montreal is labouring under, to determine if some modification cannot be made by which a part of the project may be brought into successful operation, leaving the balance to be developed as the requirements of commerce demand.

I need scarcely refer to the desirableness of a step being at once taken, with a view to obviate the difficulties under which the commercial community of this important sea port city have been for some time past labouring, for the want of proper facilities for transacting business—difficulties which will under the present order of things keep pace with the increase of trade, if they will not indeed surpass it, and thereby produce a retrograde movement, a condition of affairs so evident during the past season, as to have formed "the topic in every mouth"—and no doubt the subject of deep consideration on your part, as by none have those difficulties been more appreciated or better understood.

The McGill Street Terminus, although in one sense a component part of the entire

scheme before adverted to, was yet quite distinct from it, and capable of being carried out separately, being especially intended for the local business of the city, leaving the remaining portion, where was to be effected the immediate union of rail and water communication, for the accommodation of "the great through traffic." If the entire project were carried out simultaneously, as was intended, all would have been well, but on the contrary were only that section having reference to local business built, the trade although relieved to a certain extent would still labour under serious disadvantages.

The connection of the Railway at Point St. Charles, with McGill Street, was to be obtained by placing three lines of rails south of Mill street, or between it and the river St. Lawrence, raising the ground where necessary, to the height of twenty-five feet above summer level in the harbor, so as to be above any possible danger from ice, leaving a space for the escape of the tail race water from the various Mills, between the street so widened and elevated, and the embankment surrounding the Hydraulic Dock on the north side, of ninety feet opposite Grant, Hall and Company's Mill, from thence gradually increasing to two hundred and seventy feet at its junction with the harbor opposite the foot of the Lachine Canal. This arrangement was agreed to at the time by all the parties interested, although it appropriated space on the south side of Mill Street, owned by the various proprietors, and of the utmost importance to some of them in the successful carrying on of the business in which a large amount of capital had been embarked—those gentlemen waiving private interests and meeting the question of a great public improvement with a broad and liberal spirit in the highest degree commendable.

The uncertainty which attends the immediate carrying out of the entire scheme, now leads you to enquire whether it is not possible to engraft on the City Terminus portion of it, some of the peculiar advantages belonging to the Dock part

in other words to make it subservient to a union of rail and oceanic traffic with warehouse facilities, in addition to the peculiar mission it was originally designed to serve.

I have accordingly given the subject of your application the consideration which its great importance demands, and beg to refer you to the accompanying plans, in which a new project is developed, that will, it is hoped, with a few modifications to be mentioned at the close of this report, answer all the requirements demanded.

On examining the plan you will perceive that in place of the three lines of rails being placed contiguous to Mill street, they have been moved out a distance of one hundred and ten feet, increased in number to four tracks, and carried in a direct line, parallel with the continuation of that street to the foot of the Lachine Canal, where by means of a single turn table so arranged as to communicate with three tracks, they turn at right angles and approach for a distance of four hundred feet in the direction of the city—the line to McGill street diverging from the main one some distance up, with an easy curve, and crossing the guard Lock in the same manner as before. The rail tracks will in all cases be twenty-five feet above summer water level in the harbor, and occupy a space of fifty feet exterior to that of one hundred and ten feet before adverted to, which will furnish sites for warehouses of one hundred feet in depth, leaving the balance of ten feet for widening Mill street from forty to fifty feet.

Immediately adjoining the tracks and running parallel with them, but at a lower level, is a wharf fifty feet wide bordering on a dock three hundred feet in width, excavated to twenty-five feet in depth at the lowest stage of the river, and three thousand one hundred feet in length, extending from opposite Grant, Hall & Co.'s Warehouse, to a point opposite the foot of the Canal, where it strikes deep water connecting with the existing channel leading up the harbor in front of the city. On the south side of the dock is an embankment connecting with the main land at the upper end and from thence running the entire length of the dock, the width on top being one hundred and twenty feet, furnishing space for three lines of tracks for railway purposes, and a large amount of space of great value for the erection of temporary flour or goods sheds, or for piling deals or lumber on for shipment, which may for this purpose be brought either by railway, or by means of rafts through the Lachine Canal.

This wharf, as well as its neighbour on the opposite or warehouse side of the Dock, will be raised to the height of ten and one-half feet above summer level, or two feet higher than the existing wharves in the harbor, and therefore above the level of the late spring floods, should they ever arise to the height of last season. In the winter they will of course be under the level of the water, but will be protected against its cutting and wearing action as well as of the ice, in the most approved manner, as will be seen on reference to the various drawings.

Mill street and its continuation to the foot of the Canal will have connection with the Dock

on the north side by means of ten streets, thirty feet wide each, placed at regular intervals, and leading out onto the wharf;—these streets will be bridged for the purpose of carrying the railways across, with a clear headway between the crown of the street, and the under side of the iron girded bridges, of ten feet for cart traffic.

Passage ways from the level of the wharf will also be provided through the embankment, into the lower story of the warehouses,—they will be bridged over with iron girders of twenty-four feet span, and so placed that every opening or passage-way will accommodate two buildings—each warehouse will therefore be provided with two wide outlets underneath the railways, leading out onto the level of the dock wharf, and available during the entire season of navigation.

A convenient and expeditious mode of moving freight, destined for temporary storage, will be to transfer it from the vessel to light portable trollies, traversing the distance between the vessels and the lower story of the warehouses, on tramways of say three feet gauge, through the openings provided for that purpose in the railway embankment, and from thence elevated to the story above by means of revolving inclined planes, where being on the level of Mill street in rear, carts can convey it into the city; and to other points as required; or if necessary, the freight can be taken by carts or trucks immediately from the vessels gangways, by means of the streets leading down from Mill street underneath the railway.

Cars arriving with freight destined for shipment will discharge their loads on the second story, where during the winter season, it will remain, being above the high water line of spring floods, and on the opening of navigation can easily be transferred by slideways to the lower story, and from thence by the tramways to the receiving vessel.

Wheat will also be readily transferred from cars on either of the two sidings adjoining the warehouses, by means of conveying spouts leading from the lower story up through the embankment to the centre of the rails on each track, placed about thirty or thirty-five feet apart, so that the mouth of one will come under the centre of every car—short moveable spouts connecting them with apertures suitably arranged with sliding valves in the bottoms of the cars will allow a large proportion of the wheat to transfer itself directly into the warehouses, the balance being moved by hand shovelling [if the cars are not provided with hopper bottoms] to the discharging spout, will also follow into the warehouse. The spouts will all discharge into a conveyor, made water tight, which will transfer the wheat to elevators and by them be conveyed to the upper weighing, storage or shipping garners, and from thence be spouted directly into vessels when ever required.

The various details for accomplishing this important work with economy and facility need not at this time be pointed out, indeed the great practical experience many of you are in possession of, renders it an unnecessary duty on my



part, as no doubt in the event of the scheme being carried out, you will make such arrangements, based on the most modern and improved principles, as will move cereals with the least delay and at a minimum cost. My object in making the foregoing remarks being more with the view of drawing your attention to the peculiar advantages the plan affords, of allowing all traffic between the city, warehouses, and dock being carried on *underneath* the railway, and therefore not interfering with its business, or *vice versa*, which would be the case to a serious extent were the ordinary traffic to and from the vessels required to pass *over* the rail.

The space occupied by the warehouses is intended only to be filled up with earth to the height of summer water—the outer wall of the warehouse will be of sufficient stability to act as a retaining wall for upholding the embankment of the railway on its north side, and will be constructed throughout the entire length, to the rail level, by the company who do the work, as well as the various entrances through the railway embankment into the warehouses. The cost of this being chargeable to the party who acquires the lot abutting on the same, the retaining wall so built, becoming the foundation of the front side of the warehouse.

The revetment wall for upholding the railway embankment on the south side, will start from a secure foundation on the wharf level, and the retaining wall in front from the bottom of the dock, or from the solid rock, should such a formation be met with in the progress of the excavation.

The spaces intervening between these various retaining walls will be filled up to the heights shewn on the different sections, with material obtained from the dock excavation; the loose stones being used for filling the cribs, and for rapping or protecting the exposed surfaces of the embankments, and the solid rock excavation, should such occur, for the backing of the masonry, where not exposed to the weather or water, with durable stones for the face work brought from a distance. The estimates have all been based on the supposition that the above course will have to be followed, as from my previous experience on the Victoria Bridge, I am led to the conclusion that while the peculiar formation composing the rocky bed of the river at this point, will furnish material of a quality well fitted for backing, if used shortly after being quarried, the action of the atmosphere (wet and frost) renders it unsuitable for surface-work where exposed to the same.

As before stated, the space occupied by the warehouses is filled up to the level of summer water, but all the streets with the exception of the short ones leading down to the dock are brought up to the height of twenty-two feet above the same level. The second floor of the warehouses with which they are designed to communicate being twenty-five feet, a horse truck will consequently be about flush with the floor and admit of loads being transferred from one to the other with facility.

The tail races from the existing mills, will be constructed of solid timber, sheeted with planks to make them thoroughly water tight, and car-

ried underneath the new warehouses, railway embankment and wharf, below the level of low water, to insure the timber against decay; they will be arranged at their junction with the dock wall, so as to discharge the water into the bed of the dock, or underneath the bottoms of vessels moored to the wharf, making it less difficult for craft to approach opposite the outlets of the tail races, than if allowed to discharge themselves into the dock near the waters surface, they will each be twenty-four feet wide and six feet high in the clear, and constructed in the most substantial manner.

On referring to the accompanying drawings, you will perceive a variety of sections proposed for the dock and retaining walls—a brief description may be necessary to explain their different characters, and the circumstances under which each may be used.

**Section No. 1.**—Anticipates solid rock being met with some distance before the proposed bottom of the dock is reached, in this case it is deemed economical to allow the rock to form part of the dock wall, supporting crib work to within one foot of low water, and from thence to the top of the wharf, a solid masonry retaining wall. The revetment wall of the railway embankment will under such circumstances probably be of masonry also, as the rock excavation in the section of the dock would furnish abundant material for it. The cost of this class of work, including dock wall, wharf floor and revetment wall, will be about \$65.19 per running foot, but will of course vary according to the depth, the rock is met with.

**Section No. 2.**—Anticipates rock, the same as section No. 1, but in place of a masonry superstructure above the surface of the water, the foundation crib work is carried up to the level of the wharf, and protected above the surface of the water in the strongest possible manner, with iron rag bolts, four inch tamarack sheeting and iron straps—the revetment wall for the railway embankment is also constructed of crib work properly protected. The entire cost of this section, irrespective of embankment, as in all cases, will be about \$41.56 per running foot—the observation with reference to the uncertainty of the estimate for No. 1 section, applies equally to this.

**Section No. 3.**—In this section no rock is supposed to be encountered in the progress of the excavation—the retaining crib starts one foot below the excavated bed of the dock and approaches within one foot of the surface water, from thence solid masonry to the top of the wharf—the wharf is planked over as in all the sections with four inch tamarack plank, spiked to cills which rest on subcills and loaded or anchored with stones to prevent any movement when covered with water and ice—the revetment wall is of solid masonry resting on a broad timber platform for greater bearing surface in its foundation. The cost of a section of this description can be pretty accurately determined, and may be placed at \$72.17 per running foot.

**Section No. 4.**—Is a dock wall under the same conditions as that for No. 3, that is, starting from a foundation one foot below the bottom of the dock, but built entirely of crib work in the

most permanent style possible for that description of work to be executed, with the floor of the wharf planked in a manner similar to the other classes, and the revetment wall of crib work sheeted with tamarack plank, ragbolted and strapped with iron. The cost of the whole may be put down with some degree of certainty at \$56.68 per running foot.

On the opposite or south side of the dock, as shewn on this section, you will perceive that the embankment there made, has a crib retaining wall similar to that on the north side, and that the top of the embankment is planked over for a width of eighty feet for flour sheds, &c., the remaining forty feet for rail tracks, and the outer slope protected with stone covering to prevent the current rushing over it in the time of high water washing away the earth composing its body---the probable cost of the dock wall and protection may be put down at \$55.43 per running foot.

Section No. 5.--Supposes the rock to be met with in the progress of the excavation, a short distance below the present bed of the river, as in sections Nos. 1 and 2, and that in lieu of crib work being employed, masonry is used throughout--this estimate is of course based on uncertainty, but may be placed at \$74.99 (say \$75) per running foot.

Section No. 6.--Is a longitudinal elevation of the entire project, shewing the bridges over the streets, openings into warehouses, tail races, level of rail and wharf, &c.

Section No. 7.--Is a general cross section of the proposed warehouse, dock walls, dock, flour sheds, &c., &c., the portion relating to the warehouse is merely a skeleton section intended principally to shew the height the shipping garner must be placed in order to command the vessel with a wheat spout on a declivity of 7 to 12, should that plan of loading a vessel be adopted.

The determination of the most suitable sections of dock wall, can only be ascertained in the development of the work, thus should rock be met with as anticipated and prove of a quality suitable for use, then I would by all means recommend those sections with masonry superstructure, selecting each of them according to the extent the adoption under the peculiar circumstances of each case would be productive of economy--the work would then be of an imperishable character, if we except the simple flooring of the wharves, which might be rendered so also, by substituting macadam covering in lieu of the planks,—but on the other hand should rock not be met with, then as a measure of economy in first construction, we must adopt the wooden cribs throughout, but so arranged by bracing and packing the cross ties underneath the water, as in Section No. 3—that on the decay of the wooden superstructure it may be replaced by a stone one if desired, as in section No. 3, at a time when perhaps the Company's finances would warrant such an expenditure.

The estimates submitted for your consideration are based on Section No. 3, with masonry superstructure, resting on wooden cribs beneath low water, the backing to be obtained

from the excavation; and Section No. 4, with wooden cribs throughout.

From the foregoing brief description of the project proposed for your adoption, and by a reference to the drawings, prepared as they have been with considerable attention to completeness of detail, you will it is hoped have no difficulty in understanding the general features of the plan, I shall now proceed to describe as concisely as possible, the most feasible mode of executing the work, which at the present moment occurs to me, premising at the same time, that though it is occasionally possible to indicate generally the system or line of operation it would be advisable to adopt for the successful and economical carrying out of a work, so uncertain in its character, as the one before us may prove to be, yet that during its progress, various changes from the programme as originally marked out may be advantageously made, when it would become the duty of a skilful engineer to accommodate his *modus operandi* to any such unexpected contingency.

In taking a general view of the whole scheme, you will at once perceive that the leading and by far the most important part of the problem to be grappled with is the excavation of the dock proper—a space which extends a distance of three thousand one hundred feet in length, to an average width of three hundred and fifty-five feet, with sixteen feet in depth of difficult excavation, having from two to eight feet of water flowing over it at the lowest stage of the river in summer, and at least sixteen feet during the winter, with but a short working season left after the needful preparations for commencement have been perfected, and the certainty in view, that whatever portion of the work is left unfinished or not carefully guarded on the close of the seasons operations, will on the following year be found if not entirely destroyed, at least seriously injured. Such considerations may well stamp the work at first sight as being one of no ordinary difficulty, one which is not lessened by the fact that the tail race water, from ten large manufacturing establishments, equivalent in quantity to the entire volume of water in the Lachine Canal which now finds its passage over the site of the proposed work, will have to be provided with means of escape in another direction, without for a day stopping any of the manufactories.

On first thought it may occur that dredging would be the most proper and reliable method of removing the excavation, and under other circumstances would probably be so, but here unfortunately for the successfully working of that system, we have a very peculiar conformation of material to be contended with,—the bed of the river where examined in the neighbourhood of the proposed work, consists of solid rock, called by Sir Wm. E. Logan, the provincial geologist, "Utica Slate"—this rock in some places shews itself perfectly free from any deposit, excepting large boulders; in other places within a short distance, perhaps, it is covered with shale, quicksand, clay, and the surface with a kind of hard pan composed of boulders, gravel and clay intermixed almost as hard as the rock itself—



the distance from the bed of the river to the solid rock is in some instances from twelve to fourteen feet, with boulders ranging in weight from one to twenty tons—such was the description of the material met with on the Victoria Bridge, and judging from similarity of appearances in the formations at the two places, in so far as can be discovered, the excavation at this point will prove but a second edition of the one just described—under such circumstances therefore it would in my opinion be unwise to attempt to perform all the work by dredging—at the lower end however, where the water is deeper, it might be profitably performed and could be easily determined by trial.

If the foregoing remarks present the subject in rather a gloomy aspect, it must not be inferred that there exists no method of dispelling the clouds, and of allowing a ray of sun light to brighten up the project, as it would be a sorry termination of our labours in preparing plans, sections, and estimates, to discover that the whole was but an impracticable idea, or one which if realized would bury itself and its projectors in an overwhelming cost.

The method of dredging being then ineligible for the object in view, we must now consider the only other plan open for our adoption, viz: to unwater the work by coffer damming, and then remove the excavation by ordinary means, a mode of procedure open to no solid objection, but on the contrary presenting peculiar advantages, admitting, as it will, of opportunities to execute the work in sections, and with nearly as much facility as if performed on dry ground. To determine the number of sections into which the work should be subdivided, involves a knowledge of the amount of money the Company would be able to appropriate for each seasons operations, as each section would require to be completed a few feet above the level of low water in the same season it is commenced—the number may be assumed as not less than two or probably more than three—for our present purpose I have estimated that the work can be done in two years, and therefore in two sections, which I will now proceed to describe.

**Section No. 1**—or commencement of the work, will extend from opposite Grant, Hall and Companys Mill, downwards, a distance of one thousand three hundred and seventy-five feet, to a point opposite Hydraulic Lot No. 1, Lachine Canal; and section No. 2 from thence a distance of one thousand seven hundred and twenty-five feet, to a point opposite the foot of the Lachine Canal.

The shallow water on section No. 1, will admit at small expense of an earth embankment, say twelve feet in width on top, and raised three feet above the ordinary summer level, being placed around it—the side facing Mill street, of the coffer dam (so formed, will be placed some distance out from the street, as shewn on section No. 4, and so situated as not to interfere with putting in the foundation walls of the proposed new warehouses—the space intervening between this embankment and Mill street will form a channel or tail race, to convey the waste water of the Mills, each

way, and discharge it into the river at the upper and lower ends of the section—the outer side of the coffer dam will be placed in such position as will furnish ample room for excavating and putting in the dock wall on the south side, and form the commencement of the large embankment, by being widened and elevated with the additional material to be taken from the excavation—these sides will be connected at either end by transverse embankments of clay, thus surrounding the entire section with a water tight enclosure, allowing the water to be easily removed by steam centrifugal pumps, similar to those lately employed on the Victoria Bridge, and thus laying the bed of the section dry. The ordinary excavation can then be proceeded with after sinking wells for the pumps, to such depth as will place them one foot below the bottom of the dock, and diverting all surface drainage into them. Keeping the work moderately dry during all its future progress. The excavation should then be commenced on each side of the dock and carried to the bottom along the entire length of the dock wall, so as to admit of this important part of the work being commenced with the least possible delay, and carried on simultaneously with the remaining excavation, using the loose stones so furnished to fill the cribs. The bottom of the dock reached on both sides, a fine face will be presented for the excavators subsequent operations, as these faces can be driven each way to the centre of the dock, blasting the material down in large quantities, where it proves of more than ordinary hardness.

The opportunity thus offered of constructing the dock walls, retaining or foundation walls of buildings, with tail races on dry ground cannot be overestimated, either with reference to the quickness of time the work can be accomplished in or the decrease in cost at which the same is attained.

The total excavation on this section will amount to about three hundred and forty-eight thousand yards, and the embankment taken therefrom to two hundred and one thousand yards, leaving a surplus of one hundred and forty-seven thousand yards to be carried forward, as embankment to section No. 2, and for which an allowance has been made in the estimate for increased haul.

On referring to the detailed estimate for this section, you will find them as follows:—

1st. If masonry superstructure is used throughout on the north side, and the entire work completed as shewn on the plan and section No. 3, the cost will be \$526,427.

2d. If wooden superstructure is used, and the entire work completed in accordance with the plan and section No. 4, the cost will be \$482,330.

The surplus excavation mentioned as being carried forward to section No. 2, will be arranged in the form of two side embankments to act as coffer dams for the next seasons operations, and placed in position with reference to the dock walls similar to those on section No. 1, they will be protected with stone covering so that the water in winter may not injure them.

The commencement of the second seasons operations will be the placing of a coffer dam across the lower end of the section, where owing to the increased depth of water a double line of cribs will be used in place of the earth embankment; those cribs will be convenient lengths and on the same plan as those in the dock wall, for which purpose they will afterwards be used—the distance between the lines of cribs will be about eight feet, to admit of sheet piling and puddle being introduced—a temporary floor will be placed in the cribs near the waters surface, to contain a sufficient amount of stones to hold them firmly in place on the water being removed from the section—the work will then proceed as on section No. 1, but leaving an amount of dock wall corresponding with the lengths of the cribs in the coffer dam.—on this being accomplished the water can be let in, the temporary loading and floor removed from the coffer dam, and its cribs floated into the space left for them in the unfinished dock wall, and sunk on the foundation previously prepared

The amount of excavation on this section is about two hundred and seventy two thousand one hundred and seventy eight yards, and the embankment three hundred and ninety-nine thousand nine hundred and sixty yards, to which must be added one hundred and ninety-five thousand and eighty-three yards, the amount required to fill up the space between the canal and the proposed warehouses—or adding the excavation and embankment of both sections together, we have as follows:—

| Excavation.  | Embankment.         |
|--|---------------------|
| Cube Yards   | Cube Yards          |
| Section No. 1.—348123  | Sec. No. 1. .201034 |
| Small Dock — 18859   | Sec. No. 2.-399960  |
| Section No. 2.—272178  | Int'g sp'ce195083   |
| <hr/>  |                     |
| Total - - - 639160   | 796077              |
|  | 639160              |
| Showing a surplus required to complete the embankment of - - - - | 156917              |

This excess of embankment, over and above the excavation, is owing to the large amount required to reclaim the space above mentioned, and is allowed in the estimate at an advanced price, owing in part to the increased length of haul, and in part to the supposition that it would be taken from the bottom of the dock, or that in place of the dock being twenty feet in depth below low water in the harbor; it would be expedient to make it twenty-five feet, both with the view of furnishing the above amount, which it would just about do, and also that it might be ready for any increased draft of water future improvements may produce between this port and Quebec, a state of things almost sure to follow any large movement of commerce, as has been already proved by the increased draft from about twelve feet to twenty feet of water in the last few years, accomplished with the comparatively small means at the disposal of the Montreal Harbor Commissioners; that the trade of the country will remain satisfied with even twenty feet, or that Montreal

herself will do so, is to judge neither of them by past history.

It will therefore, in my opinion, be a wise measure to obtain this extra depth, when it can be done under such favorable circumstances, in dry excavation, and when the land reclaimed by the material so furnished will from its value more than pay the cost of deepening.

It may, perhaps, occur to you that widening the dock would be preferable to deepening it, and that in this manner the extra material will be gained. The dock has been assumed at three hundred feet in width, between the front lines of cribs, a distance sufficiently great it is thought, to admit the large majority of vessels ever likely to visit Montreal, to turn around and leave the dock bow first, but in case any one should exceed that limit in length, it would be an easy matter for her to drop gently down stern first, with the current produced by the escape of the waste water of the mills, and turn at the lower end of the dock; should you, however, prefer the increased width to that of depth, it will be about seventy-five feet more, or three hundred and seventy-five feet in all.

On turning to the detailed estimates for this section you will find the amounts as follows:

1st.—If masonry superstructure is used throughout, on north side, and the whole work completed according to section No. 3.—the cost will be \$530,426.

2nd.—If wooden superstructure is used throughout, and the whole work completed, according to section No. 4, the cost will be \$473,665.

To none of the foregoing estimates has the cost for obtaining the extra depth been added—the following will now shew the entire cost of the dock when completed to twenty-five feet draft of water.

1st.—If built with masonry superstructure on the north side, section No. 3.

|                               |              |
|-------------------------------|--------------|
| Section of dock No. 1.....    | \$526,427 70 |
| Section of dock No. 2.....    | 530,426 20   |
| Extra five feet in depth..... | 78,458 50    |

Total..... \$1,135,312 40

2nd.—If built with wooden superstructure on each side, section No. 4.

|                               |              |
|-------------------------------|--------------|
| Section of dock No. 1.....    | \$482,330 00 |
| Section of dock No. 2.....    | 473,665 95   |
| Extra five feet in depth..... | 78,458 50    |

Total..... \$1,034,454 55

shewing a difference between the two of \$100,857 95.

We will now suppose that the whole of the work is performed by the Terminus Company, or by any other joint stock Company which may be organized for the purpose, and ascertain what the direct cost chargeable to the Company would be, as it has before been stated that the expense of the masonry retaining wall, or rather the foundations of the front walls of the warehouses, and the openings into them were properly chargeable to the proprietors or parties purchasing the lots Taking in the 1st



instance the cheaper of the two, the wooden superstructure—Estimated total cost, - - - - \$ 1,034,454

|  |          |         |
|--|----------|---------|
| Section No. 1—Cost of retaining walls, - | \$38,220 |         |
| Do. Bridges into warehouses, -           | 41,676   |         |
| Section No. 2—Cost of retaining wall, -  | 73,125   |         |
| Do. Bridges into warehouses, -           | 38,203   | 191,224 |

Balance to be borne by the Company, - \$843,230

Now suppose the Harbour Commissioners build the front cribbing and wharf floor, for which they will collect the harbor dues on vessels entering the dock, the above amount will be reduced still further as follows :—

|                       |             |            |
|-----------------------|-------------|------------|
| Section 1—North side, | \$76,565.70 |            |
| “ South side,         | 75,661.95   |            |
| Section 2—North side, | 96,520.50   |            |
| “ South side,         | 95,616.75   | 344,364.90 |

Leaving amount of expenditure to be incurred by Company, - - \$493,865

If the Harbor Commissioners should decide on building the dock wall on the north side first, and leave that on the south side for a future period or whenever required by the trade, the first expenditure will be reduced to \$173,086; or if they would build the cribs to the level of low water in the first instance, and afterwards add the superstructure as called for, a further reduction can be made to \$115,724. In other words the dock can be made available for the moderate outlay of \$614,589 to the company and the Harbor Commissioners, but as the subsequent cost of the work would amount to more than if done at the outset, it would be good policy to completed it, at least on the north side, in the first instance, where the total cost would be \$671,951 to the same parties.

We will now take up the more expensive plan and treat it in the same manner.

|  |             |  |
|--|-------------|--|
| Total estimated cost.....                    | \$1,135,312 |  |
| Deduct from this sum, the following amounts: |             |  |
| Sec. 1.--Retaining walls.....                | \$38,220    |  |
| Bridges into warehouses.....                 | 59,520      |  |
| Sec. 2.--Retaining walls.....                | 73,125      |  |
| Bridges into warehouses.....                 | 54,560      |  |
|  | 225,425     |  |
| Amount of company's expenditure....          | \$909,887   |  |

If the Harbor Commissioners build the front dock wall and wharf floor, the additional deductions will be as follows :

|                                 |              |  |
|---------------------------------|--------------|--|
| Sec. 1.--North side.....        | \$74,465 35  |  |
| South side.....                 | 75,661 95    |  |
| Sec. 2.--North side.....        | 93,872 75    |  |
| South side.....                 | 95,616 75    |  |
|                                 | 339,617 00   |  |
| Amount of company's expenditure | \$570,270 00 |  |

If the Harbor Commissioners should not build the dock wall on the south side until required, the expenditure on their part would be reduced to about \$168,338. And if the masonry superstructure is build only as required, their amount may still further be reduced to \$115,744 or admitting of the dock being brought into operation for \$685,994. Sound policy would, however, construct the north dock wall completely in the first instance, when the total amount for Company and Harbor Commissioners will be \$738,608, or at a cost of \$66,657 more than the same extent of facilities could be furnished by its more perishable competitor with the wooden superstructure.

As a last resource, should neither the Harbor Commissioners or the Company be in a position to meet any of the expenditure on the dock wall proper, I would still urge the importance of excavating the channel, and using the material for making up the embankments, instead of bringing it from a distance for that purpose, being assured that on the erection of warehouses the dock walls in front of each will follow as a necessary consequence, even if they have to be built by the respective proprietors. This course will insure deep water frontage, without which the value of the land reclaimed would bear but a small per centage to that which it otherwise would, whereas on the other hand, should the attempt be made to construct the railway embankment first as proposed by some gentlemen, by means of material from a distance, and allow the dock with deep water frontage to follow whenever required, the cost would be more than doubled, if indeed the work would be practicable for any amount, of which I have grave doubts, and consequently the long sought union of the rail and harbor would be as distant in the far off future as ever.

Before leaving the subject of construction, it may be well to refer briefly to another point of some importance in connection with the dock, viz. the approach to its entrance from the present harbor.

You are probably aware that the existing channel leading up in front of the city from the long wharf to the foot of the Lachine Canal, is an artificial one, dredged about three hundred feet in width, to twenty feet in depth—the water on the outside of the channel in its entire length is comparatively shallow, to within a short distance of the upper end, where it suddenly deepens and runs out in the form of an arm at right angles with the line of the harbor, for a considerable distance, forming a natural channel of great depth, to the very entrance of the proposed dock—this outlet can be greatly improved by dredging off the lower point of the shoal, which the Harbor Commissioners would probably do for a sum not exceeding twelve thousand dollars

With the foregoing remarks on the character of the plan, the mode of accomplishing the work, and its cost, we now come to the consideration of a question, second to none of them in its important bearing on the whole project, namely, will the enterprise pay when carried out, and is it a thing in which capitalists may



invest money with some certainty of a good return.

To arrive at a satisfactory conclusion on this point it will be needful to examine the subject under the three following heads, as sources of prospective revenue.

1st. Quantity of land reclaimed, and its probable money value when disposed of by the Company.

2nd. Estimated amount derivable from railway Companies.

3d. Estimated amount derivable from dues on vessels entering the dock.

With reference to the first source of income, it may be stated that the total amount of land reclaimed by the present plan is as follows:—

|                     |                        |
|---------------------|------------------------|
| North side of dock, | 1,072,817 square feet. |
| South side of dock, | 396,000 "              |

|                   |             |
|-------------------|-------------|
| Making a total of | 1,468,817 " |
|-------------------|-------------|

Now if the total cost of the entire work be assumed at \$1,135,312, the price at which this area is obtained will be seventy-seven cents per square foot, and if we deduct from the total quantity the space occupied by wharves, railways, streets, and that claimed by the proprietors south of Mill street, the following result is obtained:—

|                                 |           |
|---------------------------------|-----------|
| North side of Dock, total area, | 1,072,817 |
|---------------------------------|-----------|

|                          |         |
|--------------------------|---------|
| Deduct space occupied by |         |
| railway tracks, 180,300  |         |
| " " wharves, 195,550     |         |
| " " streets, 184,197     |         |
| " " proprietors 173,050  | 733,097 |

|                        |         |
|------------------------|---------|
| Balance on north side, | 339,720 |
|------------------------|---------|

|                     |  |
|---------------------|--|
| South side of Dock. |  |
|---------------------|--|

|                  |         |
|------------------|---------|
| Total area - - - | 396,000 |
|------------------|---------|

|                        |         |
|------------------------|---------|
| Deduct space occupied— |         |
| By railways.....       | 132000  |
| By wharf.....          | 99000   |
| By streets.....        | 5000    |
|                        | 236000  |
|                        | 160,000 |

Making a total balance on both sides of dock of 499720 square feet for sale, and which, divided into the entire estimate as before mentioned, will make each square foot cost two dollars and twenty-eight cents.

If we now deduct the cost of the dock walls, retaining walls and bridges into the ware houses, supposing the company be not at the expense of constructing them, the cost will be reduced to a dollar and forty cents per square foot; and if to the above 499720 square feet of available space there is added the additional amount, which would be gained by increasing the width of the warehouses from one hundred to 150 feet, as will be proposed for various reasons at the end of this report, the area will be increased to 654720 square feet, and adding 44,220 dollars to the original estimate, making a total of \$1,178,642.

If the company should now, under such circumstances, perform the whole work, the cost of each foot of land reclaimed will be seventy-two cents; and after making the deductions for streets, wharves, railways and proprietors, one dollar and eighty cents per foot, and still further

reduced by deducting the costs of retaining walls and warehouse bridges, to a dollar and forty-five cents for each foot. But should the Harbor Commissioners assume the cost of the dock-wharves the amount each foot of surface to be disposed of by the company will cost, would be still further reduced to ninety-four cents.

Such is a statement of the actual cost of a square foot of land reclaimed from the river, and provided with deep water frontage and railway connection, what the actual value of it would be, can only be determined approximately by comparing it with the price land is held at in the neighbourhood, but without such facilities for the transaction of business as the site before us presents. The unoccupied space on each side of the foot of McGill street is held by the various proprietors at from two dollars to one dollar fifty cents per square foot, for ordinary warehouse purposes. We cannot go far wrong then to suppose that sites for warehouses &c., such as are presented on the Mill street project, with immediate rail. ship, and cart connections for each, can be of less actual value than those on McGill street without such extensive and important facilities—the following estimate will shew the probable value based on this supposition—

|   |                 |
|---|-----------------|
| Available land held by the Company on the north side and bordering immediately on the dock, 311.720 sqr ft. | \$2---\$623,440 |
|---|-----------------|

|  |                                 |
|--|---------------------------------|
| Do, do, not bordering immediately on the dock, but lying between Mill street continuation and Lachine Canal..... | 183.000 sqr ft. \$1.50, 274,500 |
|--|---------------------------------|

|   |                       |
|---|-----------------------|
| Land on South side, bordering immediately on the dock, but not available during winter,.. | 160.000. \$1— 160,000 |
|---|-----------------------|

|                                  |             |
|----------------------------------|-------------|
| Total estimated value of laad,.. | \$1,057,940 |
|----------------------------------|-------------|

Amounting to within 120,702 dollars of the entire cost or the work, of after deducting the cost of the retaining walls and warehouse bridges chargeable to the proprietors, there will be a surplus in the value of the land of 104,723 dollars over the cost, and if still further reduced by the amount of the dock wharves, there will be an excess in value amounting to 444,340 dollars over and above the Companys expenditure.

A correct estimate of the probable revenue to be derived from railway operations, is more difficult to arrive at, from the fact that it based on number of passengers and tons of freight passing over the rails, the data for the esti-

mate will fluctuate from year to year, and will also be affected to a considerable extent by the determination the Terminus Company may arrive at respecting the site for the location of the railway station.

Should it, owing to the opposition which has been met with to the closing up of the foot of McGill street, and crossing the Lachine Canal, as well as the action of the Grand Trunk Railway in establishing a second depot on Bonaventure street, decide on abandoning that expensive site, and adopting in place of it the eligible strip of ground 950 feet in length by 200 feet in depth, lying between the continuation of Mill street and the Lachine Canal, a large amount for land purchase, and an expensive crossing of the canal will be avoided—should this point be selected, it will offer sufficient space for a large passenger station fronting the city, and connected with it if necessary, by two additional bridges over the canal, for ordinary traffic. In rear of this building of seventy-five feet in depth, is space for four railway tracks, occupying fifty feet, and leaving a balance of seventy-five feet in depth between the tracks and the continuation of Mill street, for a local freight depot.

These two station buildings could be connected with each other above the rail tracks, and have the upper story so furnished divided off into a great number of offices for merchants, and commission agents, and would yield a large income, on account of proximity to railway station, warehouses, and shipping. The erection of this building could commence at the upper end of the station reserve, and be gradually extended from time to time, as the increase of the traffic would demand, until the extreme length is attained. The entire depot would be accessible on all sides by streets from sixty to one hundred feet in width, if required, with the railway operations confined to a space beyond all interference with ordinary traffic.

But as this report is not specially intended for the City Terminus Company, it will not be necessary to go into minute details either with reference to the general arrangement of station buildings or to the amount which would be saved that Company by confining their operations to the south side of the Canal—it will suffice from our present purpose to assume as the minimum revenue to be derived from the Grand Trunk Railway Company, the amount of their guarantee, to the McGill Street Terminus Company, on \$200,000, at  $7\frac{1}{2}$  per cent, equivalent to \$15,000 per annum.

With a dock of this magnitude, and so extensive a system of warehouses in connection with the rail and shipping, a third connection with the narrow gauge roads leading to Boston, New York, and all the various cities and towns in the neighbouring country, would become so much of a necessity as speedily to be obtained, by placing the third rail over the Victoria Bridge and leading it from thence to the warehouses and Terminus—the additional revenue this would yield, at the very lowest figure, would be \$5,000—making a total for the two guages of \$20,000 per annum, and re-

presenting a capital of \$266,000 at seven and one half per cent.

Any estimate of the amount to be collected from shipping dues, will of course be based on uncertainty—we must therefore place the sum at a very low figure, to insure being within the mark, and call it \$25,000 per annum.

From the foregoing deductions, which are susceptible of increase or diminution according to your idea of the correctness of the data upon which they are founded, we will now proceed to condense the whole into one result. If the total cost be assumed at \$1,178,642, at eight per cent, the interest on the outlay will amount to

|  |          |
|--|----------|
| To meet this there is the interest             |          |
| on the land sales amounting to                 |          |
| \$1,057,940 at say 8 per cent                  | \$84,635 |
| Estimated annual revenue from                  |          |
| railways                                       | 20,000   |
| Estimated annual revenue from                  |          |
| Harbor   | 25,000   |
| shewing a surplus of \$35,344 over the amount  | 129,635  |
| required to meet the interest, or about 11 per |          |
| cent on the total capital invested.            |          |

In the above estimate of \$1,178,642, is embraced the cost of the retaining walls and bridges into the warehouses, chargeable to the various proprietors, amounting to \$250,726, which if deducted from the total amount will leave a balance of \$927,917 to be provided for by the Company, and at eight per

|  |          |
|--|----------|
| cent per annum will require                    | \$74,233 |
| Taking the same revenue as before estimated at | 129,635  |

|  |          |
|--|----------|
| Leaves a balance after paying 8 per              |          |
| cent of  | \$55,402 |
| Equal altogether to about 14 per cent per annum. |          |

We will now present the subject in the most extreme case it can possibly assume, and suppose that the excavation—coffer damming, and pumping will cost double the liberal estimate made for the work—this will add \$366,641 to the above amount of \$927,917, making a total of \$1,294,558, which at 8 per cent will give \$103,564 to be provided annually as interest, but the foregoing estimate of revenue still holding good, shews a balance after paying that amount of \$26,071, or equal to a total yearly dividend on the amount invested of ten per cent. under such extraordinary circumstances.

It may be well to mention here, that in the foregoing summary the more expensive of the two plans has been used, that with the masonry superstructure for the dock walls, the difference in cost of the two \$100,857, will enable you to substitute the cheaper plan for purpose of comparison should it be desired.

I now come to the subject briefly alluded to on page three of this report, with reference to a few modifications in the general features of the scheme submitted to you, which will in my opinion add much to its value as a paying speculation, and also give increased facilities for carrying it out, as well as additional space for the transaction of business, a point in itself of the utmost consequence to its future successful working.



The views now about to be given, I regret to say are not participated in by some of the proprietors, whose opinions are nevertheless entitled to much respect, and who will no doubt bring them before your notice. This difference in opinion is regretted the more from the fact of the otherwise complete unanimity of mind existing between those gentlemen and myself relative to the work in other respects, and the very valuable suggestions of a practical character, they have kindly furnished during the preparation of the plans.

The changes from the present plan may be briefly stated as follows:

1st, I propose to widen Mill street to at least sixty feet, in place of fifty feet, as shewn on the plan.

2d, To increase the depth of the warehouse lots bordering on the north side of the dock from one hundred to one hundred and fifty feet, and thereby straighten the line opposite Lyman's and Gould's mills.

3d, To increase the space for the railway tracks in front of the warehouses from fifty to sixty feet.

4th, To increase the wharf space from fifty to at least sixty feet.

With reference to the first, it may be mentioned that in the event of the warehouses being erected, Mill street would become a perfect thoroughfare for cartage between them and the city, forming as it would the only line of approach. The horse trucks now in use measure about twenty-five feet in length, and with two backed up, receiving or delivering freight, to the mill on one side and the warehouse on the other, the thoroughfare, if made but fifty feet, would be completely blocked up; it would in fact be found that sixty feet would furnish scant room enough; and as the proprietors have liberally bestowed ten feet to widen the street from forty feet to fifty feet, the Harbor Commissioners should show equal liberality in moving the southern limit of the proprietors' lands ten feet further out, providing they give the same amount to the street on the north side, making it sixty feet in width.

It may be urged that Commissioner street, in front of the city, is of less width, and that it accommodates all the present traffic between the existing warehouses and the harbor. The parallel between the two cases will, however, not hold good, as Commissioner street has warehouses but on one side, and, moreover, is provided with a great number of lateral outlets in the form of streets tapping its traffic at right angles, while Mill street, on the other hand, will be enclosed on both sides with mills and warehouses, and form a main artery seventeen hundred feet in length, without any lateral escape for the traffic flowing over it into the city. This extra width will not prevent light iron girders being placed over head, to connect the buildings on each side of the street, for the transit of flour or wheat. For motive power I would propose taking the water from the bulk heads now in use, by iron pipes, underneath mill street, to the wheels to be placed in the new warehouses.

The extra depth for the warehouses is proposed for the following reasons.

1st. It will give a much larger channel for the escape of the waste water from the mills, during the progress of the work, a point of great importance in dealing with this difficult problem.

2nd The additional land so furnished, will give a clear profit over and above the extra expense of at least \$300,000. Without this increase, there would be no inducement for a company to undertake the work on section No. 1, simply for the benefit of the mill proprietors.

The extra width of fifty feet in front of each lot could be assumed by the proprietors of the lots by taking stock for the value of the land, the amount of which would enable the Company to do a large amount of the work, and the entire depth of one hundred and fifty feet would then be held by the present proprietors. This arrangement will also admit of the railway and wharf being carried in a straight line the entire length of the dock, without interfering with Lyman's buildings on the south side of Mill street. If on the other hand it should be decided not to make this increase in depth, and a company undertake to do the work in accordance with the present plan of one hundred feet in depth, I would still strongly urge the straightening of the line by making some arrangement with the proprietors affected thereby.

It appears to me that in view of the great value of dock frontage, and the necessity of a certain amount of warehouse area being required, it would be more desirable to make the side of the warehouse fronting on the dock of less dimension, and allow the increased area to be derived by additional depth; by this means a greater number of lots can be obtained, and enable them to be sold at an advanced price—in this case one hundred and fifty feet in depth will be productive of greater advantages than one hundred feet.

The width of fifty feet, proposed by the gentlemen referred to, for the four tracks of rails, is rather scant measure by increasing it to sixty feet, will give them more room, and allow of space for a foot walk, or promenade on the top of the revetment wall for the use of citizens wishing to view the crowd of shipping in the dock—an iron railing for their safety could be placed along the out side, similar to that on Commissioner street; this extra space of ten feet will protect the iron girders carrying the railway over the openings and streets, from the shoving of the ice, should it ever reach the height of their underside, and also admit of permanent supports being erected for the service of wheat spouts leading to the vessels, until the period arrives when the erection of permanent buildings on the south side of the dock, will allow also of permanent additions being made to the warehouses on the north side of the dock, and extending over the four track of rails.

The width of the wharf is a question, which would probably be decided by the Harbour Com-

missioners, I would, however, propose an increase of ten feet, making it sixty in place of fifty feet as shewn on the plan, for the reason that many of the gang ways used by the vessels, are about forty feet long, and will occupy say thirty feet of the wharf, leaving the balance of thirty feet between their lower ends and the revetment wall, for the passage of carts or trucks coming down with, or for freight onto the level of the wharf.

Such are the arguments I would urge for the proposed modifications of the present plan submitted, and which I consider my duty to frankly give you, in order to make it perfect in every respect, at least in so far as my own opinion goes--on the other hand, the objections urged by the proprietors referred to, against those increased dimensions from the difficulty they will create in the handling of wheat, are from the great practical experience possessed by those gentlemen in this particular department, entitled to consideration. You will permit me to add, however, that I anticipate no difficulty which cannot be easily surmounted, but probably necessitating mechanical appliances differing from those now made use of for such service.

Before concluding this report, I may mention that it has been for some time in contemplation to remove the waste weir on the Lachine Canal, near Grant Hall and Company's Mill, to a point some distance out, and thus create an extension of canal basin at that place. If this is done, the excavation necessary for widening the present tail race from the waste weir, will furnish good material for the coffer dam on section No. 1, but as this basin is a separate work, although of some importance in connection with the dock I have not embraced it in the estimate.

Should the Terminus Company decide on abandoning the McGill street site, as it will probably be their interest to do, in view of the greater advantages to be derived from a site on the south side of the canal, the swing bridge proposed to be placed over the guard lock, Lachine Canal, could be transferred to the entrance into this basin, and eventually be paid for by the Hydraulic and Dock Company when their scheme is carried out, as the basin in question would form the entrance from the Lachine Canal into the large Hydraulic Dock.

The total length of dockage with twenty or twenty-five feet water on the Mill street scheme is 7400 feet, or equal to one and two fifths miles.

One great advantage of the plan before us is the opportunity it presents of having its value nearly doubled by future extension and with comparatively a small outlay, but as I have already written at much greater length than at first intended, on the arrangement proposed for the north side of the dock, in which you are more immediately interested, I shall trespass but briefly on your patience in describing the nature of the improvements capable of being made on the south side.

As already described in the preceding report, the work contemplated at the present time on the south side of the dock, consists of a wharf

and embankment one hundred and twenty feet in width, running its entire length and raised ten and one-half feet above summer water line, for the reception of temporary flour and goods sheds, &c., for which purpose it can be used up to the time of more permanent and complete structures being required for the trade. The extremely shallow water south of this embankment can be filled up to summer water for a distance of 150 feet in depth, for the reception of a second tier of warehouses, with wharf, revetment wall, openings through the railway embankment, in front of the buildings and railway tracks, in every respect similar to that on the north side—an embankment raised twenty-five feet high above summer level, and sixty feet in width, will be placed in rear of the new tier of warehouses, for connecting the cart traffic with them, and also to protect the buildings from danger of ice. When the Hydraulic Dock scheme is carried out, another tier of Mills can be placed exterior to this street, or between it and the Hydraulic Dock Wall, the whole forming a repetition of the existing mills at the foot of the Lachine Canal, Mill street, and the new warehouses proposed for the north side of the dock, with the water supplied to the wheels in the buildings from the Lachine Canal on one side and the Hydraulic Dock on the other and from thence conveyed into the proposed dock as a tail race.

The earth in the embankment required for this new line of warehouses on the south side could be obtained from the excavation of the contemplated government basins near Taits Dry Dock on the Lachine Canal, and prove a decided exemplification of the proverb "killing two birds with one stone."

After the erection of these warehouses on the south side of the dock, the space occupied by the rail tracks on each side of the dock could be built over, leaving headway enough for the engines &c, and thus obtain much additional valuable storage room over head.

The promenade along the revetment walls in front of the buildings on each side of the dock can be increased in width by bracketting from the face of the walls and planking over, as the entire dock will be, so to speak, "land locked" or entirely protected from floating ice, forming an admirable harbor for vessels during the winter.

I have thus gentlemen, endeavoured to place before you a project extensive in its character, but susceptible of being carried out for an amount within the reach of the mercantile community of this city.

I have endeavoured to shew how in its execution one part may be made to accomplish another; with every prospect of being a paying speculation to those embanking in it, and the same time creating facilities of the utmost importance, not only for the commerce of this city, but of the Province and great west generally.

I have the honor to be, Gentlemen,

Your obedient servant,

CHARLES LEGGE,  
Civil Engineer.











Rev. James Hudson  
L. L. L.  
Queens, New York  
Kingston  
Cra.





